

PATENT SPECIFICATION

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DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Method of Electrolytically Cleaning Iron Moulds

We, BROCKWAY GLASS COMPANY, INC., a corporation organised and existing under the laws of the State of New York, United States of America, of Brockway, Pennsylvania, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of cleaning metal mould surfaces and more particularly to a method of cleaning the cavity portions of cast iron or steel moulds such as are employed in manufacturing glassware.

The mould cleaning method of the present invention will be discussed herein and described in detail in connection with cleaning the surfaces of cast iron moulds such as are used in moulding glassware, particularly glass containers, but it is to be understood that the method may be usefully employed, within the purview of the present invention, wherever similar cleaning problems are presented, for instance in cleaning the mould surfaces of moulds for rubber and other mouldable materials.

In the cast iron moulds which are conventionally employed in manufacturing glass containers and other glass articles a very special and highly vexatious problem exists by reason of the accumulation on the mould surfaces of stains and deposits which build up to a point where they harmfully affect the moulding process in various ways and must accordingly be removed from time to time. The only really workable mould cleaning method of the prior art, from a practical standpoint, is by mechanical abrasion of one form or another, despite numerous objections and disadvantages to this mode of removing harmful surface deposits and accumulation of foreign matter.

The most common prior method has been [P.

by the use of abrasive sticks, either purely 45
by hand rubbing or, in some cases, by rotating the moulds in a lath-like machine to clean circular cavities. This method obviously removes metal from the mould surface, and usually in an uneven manner since more 50
abrasion is applied where the concentrations of dirt and soil are the greatest. This method accordingly produces uneven and off-tolerance ware and successive cleanings enlarge the mould cavity to a point where the mould is 55
no longer usable.

Furthermore, abrasion as thus practised is inevitably greater at the edges of the mould cavities and tends to round off such edges resulting in highly objectionable flash around 60
the moulded article at the mould joint or parting line. Sandblasting has also been employed with equally deleterious results. The obviously slow and laborious nature of these methods of mould cleaning is, of course, a further important 65
disadvantage.

Furthermore, mechanical abrasion methods of cleaning round off sharp edges within the mould cavity and are especially deleterious where surface designs or lettering are present 70
in the mould cavities, due to erosion of such designs and lettering by abrasion. Still further, the prior art abrasive methods tend to clog vent openings in the moulds which must frequently be redrilled to renew their effectiveness. 75

In seeking to avoid the multifarious objections to mould cleaning by mechanical abrasion or sandblasting, acid cleaning and other chemical or electrolytic cleaning methods have 80
been attempted, but without success. Either the problems of mould surface erosion have not been avoided or the cleaning has not been properly effected, or both. Acid cleaning is particularly harmful to the mould surfaces, 85
frequently resulting in pitting thereof, and prior art alkaline chemical cleaning methods have been notably unsuccessful.

The present invention provides a highly effective method involving a novel composition of ingredients in a liquid cleaning solution, electrolytic action in conjunction therewith and very importantly, a continuous treatment and rejuvenation of the cleaning solution to maintain the effectiveness thereof by continuously removing accumulations of iron therefrom. A key factor in the success of the present cleaning method resides in the use of a very high percentage of a chelating or sequestering agent, sodium gluconate, which has the ability to remove the iron oxides without removing metallic iron from the mould surface. Other sequestering agents may be available for this purpose.

It has been found that, despite the unusual initial effectiveness of the present cleaning solution, the effectiveness of the chelating agent falls too rapidly for this method to be of practical value without employing, in conjunction therewith, a continuous removal of accumulations of iron oxide, loose carbon and soils from the cleaning solution to continuously rejuvenate or maintain the sequestering properties of the chelating agent.

According to the invention in a method of electrolytically cleaning iron moulds such as are used in moulding glass articles the cleaning is effected with the iron mould as cathode using an electrolyte comprising an aqueous solution of sodium hydroxide and sodium gluconate having a sodium hydroxide: sodium gluconate ratio in parts by weight of 2:1 and the amount of water being equivalent to 6.3 to 10.8 parts by weight, and the concentration of iron in the electrolyte is maintained below 0.1 gram per litre by continuously removing iron electrolytically from the electrolyte in a separate electrolytic cell.

In a preferred form the method of the present invention proceeds generally as follows, although it is to be understood that various modifications may be effected without departing from the principles of the invention, which are not limited excepting as defined in the appended claims.

The moulds are preferably first immersed in a pre-cleaning and degreasing tank containing an alkaline degreasing compound which may comprise any of a variety of proprietary mixtures which are commercially available for this general purpose. The objective of this step in the process is mainly one of economy whereby the heavy and less tenacious soils are removed in less expensive cleaning solutions. This step in the process is expedited and rendered more effective by electrolytic action.

To this end the parts to be cleaned are connected as cathodes in an electrical circuit with carbon anodes, the whole being immersed in the precleaning and degreasing bath with a low voltage rectifier supplying approximately 100 amperes of current per square foot of surface to be cleaned at a potential of six

volts. In the present instance the immersion time is about six minutes. In this precleaning and degreasing step the electrolytic circuit causes hydrogen gas to evolve at the cathode, the surface to be cleaned, which tends to force the soil away from the metal surface of the mould and assists the chemicals in the solution in attacking the surface to be cleaned and in dissolving and emulsifying the material thus removed from the mould surface.

Following the precleaning and degreasing step the mould holding and conveying devices, including moulds, supports and electrodes, are moved to a rinse bath which may be a cold water static rinse of about six minutes duration but which may be rendered more effective by using steam or hot water sprays or other similar rinsing or washing expedients. This rinsing step removes soils which are loosened in the precleaning and degreasing operations so that they are not carried along to the next step in the cleaning process which involves stronger and more expensive cleaning preparations.

The step in the cleaning process which follows the precleaning and the first rinse is the critical and important one in the present mould cleaning method and, together with the continuous rejuvenation of solution which accompanies this step in the process, comprises the novel and decisive portion of the process as a whole and is responsible for the highly successful mould cleaning which, for the first time, may be accomplished entirely without mechanical abrasion of the mould surfaces and without resort to harmful acid treatment of the mould surfaces.

While mechanical abrasion is virtually eliminated, some final polishing or buffing may be effected where necessary or desirable. Specifically, after final cleaning and rinsing a carbon smut may be present on the mould surfaces and the most effective way of removing this final residue is by buffing with soft wire brushes.

The cleaning bath in which mould parts are immersed in this third step of the cleaning operation, in the preferred form disclosed here by way of example, comprises a solution of sodium hydroxide and a chelating or sequestering agent, sodium gluconate. Sodium gluconate is believed to have been used in relatively small quantities in certain proprietary, general purpose cleaning compounds and rust strippers of the prior art. However, the use of sodium gluconate in proportions previously contemplated would have no useful effect in the present cleaning problem.

The cleaning solution of this step in the present cleaning process contains concentrations of caustic and sodium gluconate in proportions of 32 ounces per U.S. gallon of free sodium hydroxide and 16 ounces per U.S. gallon of sodium gluconate. Even in the concentrations just named, the chelating agent,

sodium gluconate, would retain its effectiveness as a sequestering agent for so short a time as to be impractical excepting for the provisions which are made for continuously removing iron from the cleaning solution, as will appear later herein.

In the present example the solution is maintained at a temperature of from 180 to 190 degrees F. and the desired strength, which is important in the success of the method, is controlled by titration to phenolphthalein end point for sodium hydroxide and by back titration with sodium oxalate to determine the amount of sodium gluconate oxidised by a known amount of ceric ammonium perchlorate.

The extreme stubborn and tenacious soils which must be dealt with at this stage of the cleaning method include heat scale, silicone resin residue, graphite, and oxides formed on the surfaces of the moulds from their exposure to high heat, release agent applications and moisture.

In this important step of the cleaning process electrolytic action is again used to ameliorate the cleaning and in this case it has been found that results are substantially improved by a periodic reversal of the applied current. In the present example a six volt direct current of the same intensity as in step one may be employed and the current is applied as before, with the mould constituting the cathode, for fifteen seconds, whereupon the current is reversed for five seconds, the mould then being the anode.

This cycle of current reversal is repeated during the entire immersion period which in the present instance is twelve minutes. The current intensity and the timing of the reversal cycles have been arrived at empirically and seem to produce optimum cleaning of the types of soils and deposits found on glass moulding equipment. As will appear later herein, the arrangement of the moulds and the electrodes is preferably such that the electrolytic action is concentrated upon the moulding or cavity surfaces of the mould parts.

An essential and highly important part of this third step in the cleaning cycle resides in the continuous stripping of the cleaning solution to continuously remove iron oxide, carbon and soils therefrom and thereby maintain the sequestering or chelating effect of the sodium gluconate of the cleaning compound. This continuous stripping phase of the third step of the process will be more fully described after the remainder of the direct steps in the cleaning process have been set forth.

In the fourth step of the cleaning process set forth in the present example the moulds, with their holders, are immersed in a water rinse to remove the remaining loosened soil and to wash off any chemical carry-over remaining on the moulds. A fifth and final step comprises a hot water rinse which is employed

to remove any remaining chemical solution on the mould surfaces and, by the resultant heating of the moulds, to speed their drying. Both the fourth and fifth rinsing steps may be for about six minutes.

Reference will now be had to the continuous stripping or rejuvenation which accompanies the important and critical third step in the cleaning process of the present invention. Cleaning solution from the tank employed in the third step of the process is continuously circulated to a so-called dummie tank or cell and back to the cleaning tank. As previously stated, this is extremely important in continuously renewing the sequestering action of the chelating agent, sodium gluconate.

The ability of a chelating agent to remove and hold iron oxides in solution appears to be quite limited and it has been found that without the continuous rejuvenation herein provided the cleaning ability of the solution in this principal step of the present process would be too short-lived to be of practical significance. Furthermore, when the iron in the cleaning solution reaches a content of approximately 0.15 grams per litre the iron will plate out of the solution back onto the mould surface. This deposits a thin hard film of iron on top of the soil already present on the mould surface, producing a surface which is all but impossible to clean.

In the dummie tank employed in the example of the process of the present invention which is set forth herein by way of example the cleaning liquid which passes there-through comprises an electrolyte, the cell being provided with a fixed carbon anode and a cathode of expanded metal, namely the expanded metal of commerce comprising common steel such as is used in various structural applications. The current density is preferably selected to hold the total iron content of the solution down to a level of 0.04 to 0.08 grams per litre by depositing excess iron on the expanded metal cathode by electrolytic action. In any event, it appears that good practice of the method of the present invention dictates maintaining the iron content of the cleaning solution below the level of 0.1 grams per litre.

A further very beneficial effect of this stripping of the cleaning solution and the consequent maintenance of its efficacy results from the fact that grease and oil deposits not removed in the first precleaning and degreasing step and thus carried over into the principal third step of the cleaning process are distilled from the solution. If these residual oils and greases are not removed from the caustic-gluconate solution of the third step, the effectiveness of this step in removing the more stubborn and tenacious stains and soils is greatly reduced. The relatively higher temperatures developed in the dummie tank due to the relatively high current flow cause

the oils and greases to collect on the surface and volatilise, leaving a removable surface scum on the liquid in the dummyming tank.

5 The apparatus employed in carrying out the method of the present invention is in large part conventional and relatively simple. Nevertheless, a typical apparatus setup is illustrated somewhat schematically and diagrammatically in the accompanying drawings, merely by way of completing a disclosure of the modus
10 operandi of the invention in one specific and concrete form. However, it is to be understood that the apparatus employed is subject to considerable variation without departing from the underlying principles of the invention as
15 defined in the appended claims.

In the drawings:—

20 Figure 1 is a somewhat schematic top plan view of one form of apparatus setup which may be employed in performing the mould cleaning method of the present invention;

25 Figure 2 is a front elevational view of a carrier for supporting moulds and transporting the same between the several stations involved in the form of the present method set forth by way of illustration;

Figure 3 is an end elevational view of the carrier of Figure 2;

30 Figure 4 is a view similar to Figure 2 but adapted for handling mould parts of different form;

Figure 5 is an end elevational view of the carrier of Figure 4;

35 Figure 6 is an elevational view of a dummyming tank employed for continuous rejuvenation of the mould cleaning solution; and

Figure 7 is an elevational view of one of the electrodes employed in the dummyming tank.

40 In practicing the method of the present invention the mould parts to be cleaned are supported by a series of carriers which move the parts to and from the successive cleaning stations. These carriers in turn are supported and moved by a machine of a type familiar
45 to those versed in the electroplating art. One such machine is virtually standard in electroplating and is known as a Hansen-Van Winkle & Munning Co. machine.

50 This machine comprises a central support which is designated by the numeral 10 in Figure 1 and includes a series of horizontally radiating arms 11. The machine is so arranged that the arms move about the perimeter of
55 the central support in unison and the machine further includes mechanism whereby the individual arms move upwardly and downwardly in accordance with any desired pattern of movement to immerse holders suspended
60 therefrom into the various tanks and raise them therefrom. In Figure 1 the numeral 12 generally designates a series of carriers which are suspended from several arms 11.

65 Referring jointly to Figures 2 to 5, the carriers there shown each comprise depending

support portions 15 and a bottom or platform portion 16.

70 Referring particularly to Figures 2 and 3, annular metal support plates 17 rest upon the bottom or platform 16 and are jointly electrically connected as at 18 to form an electrode in an electrolytic circuit. In Figures 2 and 3 the numeral 20 designates conventional
75 mould parts which comprise mating semi-cylindrical halves and, in the present instance, two pairs of mould parts are so positioned that the cavity portions of each pair face each other and a carbon electrode 21 is supported to extend downwardly within the cavity so as to be in conveniently close proximity to the
80 mould surfaces. The carbon electrodes 21 are jointly connected by conductors 22 to form electrodes opposing the mould parts 20 in the aforesaid electrolytic circuit, the mould parts 20 resting upon the metal support plates 17
85 in electrical contact therewith.

The carriers 12 of Figures 2 to 5 are identical excepting for the electrode arrangements thereof. In the carrier illustrated in Figures 4 and 5, a metal conductor and support plate 25 on platform 16 is connected as at 26 to form one side of an electrolytic circuit and mould parts may be placed thereon as at 27 with their mould surfaces or cavity portions facing upwardly. An opposing electrode
95 in the present instance comprises a horizontal carbon plate 28 supported from a pair of carbon post members 29 which are supported from and electrically connected by a pair of conductor bars 30, whereby the carbon plate 28 forms the opposing electrode of an electrolytic circuit.
100

The several conductors 18, 22, 26 and 30 lead from the carriers 12 to the central support portion of the aforesaid standard electroplating machine 10 which conventionally includes current supply means and brush means for supplying D.C. electrical energy to the conductors and thus to the several electrodes according to any desired pattern of current
110 direction and timing, so that current may be supplied to the electrodes to suit the conditions described in a previous portion of this specification for performing the method in accordance therewith.
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In Figure 1 the several tanks for performing the successive steps in the mould cleaning method of the present invention are indicated schematically. These tanks are of stainless steel and comprise a tank 35 for precleaning and degreasing, a tank 36 for the rinse which follows the same, and a tank 37 which is the principal cleaning tank employed in the third step of the method of the present invention.
120 Tank 37 contains the previously described solution of sodium hydroxide and sodium gluconate. A tank for the rinse which follows the principal cleaning step is designated 38 and a tank for the final hot rinse which has previously been described is designated 39.
130

It will be understood by those skilled in the electroplating art that the machine 10 operates automatically to raise each arm 11, move the same over tank 35, lower the same to immerse its holder 12, raise the same after a pre-arranged dwell time, and repeat this cycle in connection with each of the tanks 36, 37, 38 and 39 in accordance with the previously described method to carry out the steps outlined therein.

The means for continuously removing iron from the solution in the tank 37, that is from the sodium hydroxide-sodium gluconate solution employed in the third step of the method, comprises a dummyming tank shown schematically at 40 in Figure 1 and in elevation in Figure 6. Liquid from the bottom of the tank 37 is continuously pumped to the bottom of the dummyming tank 40 through a conduit 41 by means of a pump 42. A return conduit is designated 43 and leads from the upper portion of dummyming tank 40 to the tank 37. Return conduit 43 is so arranged that at a given level liquid from the dummyming tank 40 flows back to the tank 37 by gravity flow.

In the dummyming tank a pair of carbon electrodes 45 comprise anodes in an electrolytic circuit and a grid in the form of a hollow cylindrical vertical sleeve member 46 comprises a cathode, the anode and cathode being supplied by electrical conductors designated 47 and 48, respectively. The cathode 46 is of iron or steel and may conveniently comprise a sheet of expanded metal formed into a vertical hollow cylinder. The manner in which the electrolytic circuit thus established in dummyming tank 40 deposits iron from the solution on the cathode 46 has previously been described. The iron of the cleaning solution is electrodeposited on the grid 46 and, when the deposit reaches a point where efficiency of the grid diminishes, the same may be replaced. The capacity of the tank 40 is 55 gallons and the flow into and out of the tank is from 3 to 5 gallons per minute. With the proportions of the electrodes as shown in Fig. 6, a current flow of 500 amperes has been found adequate for holding the total iron content of the solution down to a level of 0.04 to 0.08 grams per litre.

WHAT WE CLAIM IS:—

1. A method of electrolytically cleaning iron

moulds such as are used for moulding glass articles, in which the cleaning is effected with the iron mould as cathode using an electrolyte comprising an aqueous solution of sodium hydroxide and sodium gluconate having a sodium hydroxide: sodium gluconate ratio in parts by weight of 2:1 and the amount of water being equivalent to 6.3 to 10.8 parts by weight, and the concentration of iron on the electrolyte is maintained below 0.1 gram per litre by continuously removing iron electrolytically from the electrolyte in a separate electrolytic cell.

2. A method as claimed in claim 1 wherein the direction of the applied electric current is periodically reversed.

3. A method as claimed in claim 2 wherein the moulds are made the cathode of the electrolytic circuit for periods of 15 seconds and the anode for periods of 5 seconds.

4. A method as claimed in any of claims 1 to 3 wherein the current density in the separate electrolytic cell is such that the concentration of iron in the electrolyte is maintained between 0.04 and 0.08 grams per litre.

5. A method as claimed in any of the preceding claims wherein the moulds are first subjected to a preliminary cleaning and degreasing treatment followed by rinsing.

6. A method as claimed in claim 5 wherein the preliminary cleaning and degreasing treatment is an electrolytic treatment.

7. A method as claimed in any of the preceding claims in which the cleaning is effected by means of a current of approximately 100 amperes per sq. ft. of mould surface to be cleaned.

8. A method as claimed in any of the preceding claims wherein the moulds are subsequently rinsed.

9. A method as claimed in claim 8 wherein the moulds are finally rinsed in hot water.

10. A method of electrolytically cleaning iron moulds substantially as hereinbefore described.

11. Iron moulds whenever cleaned by a method as claimed in any of the preceding claims.

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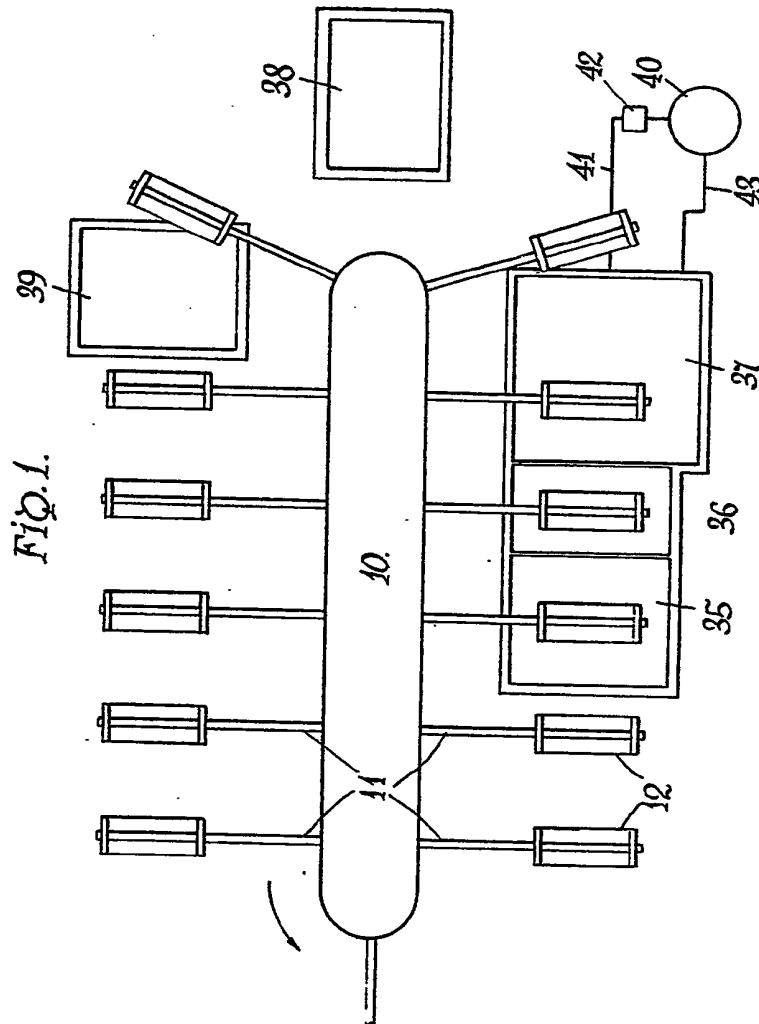
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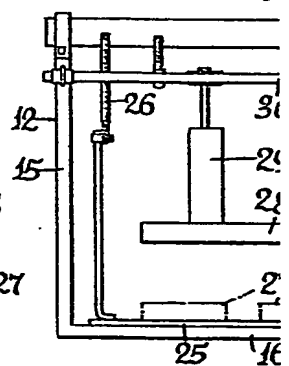
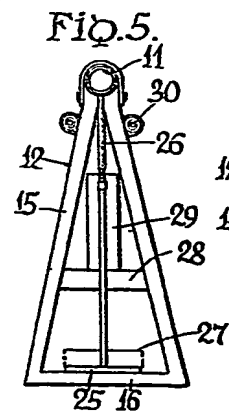
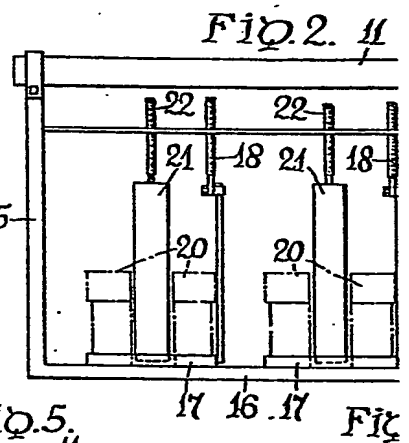
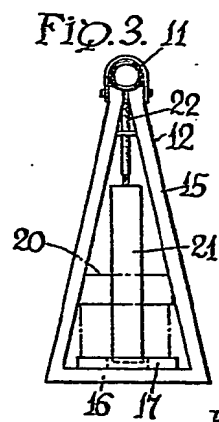
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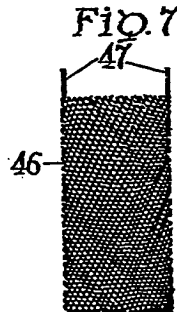
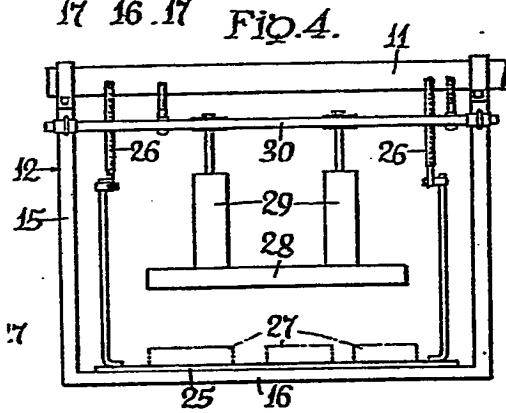
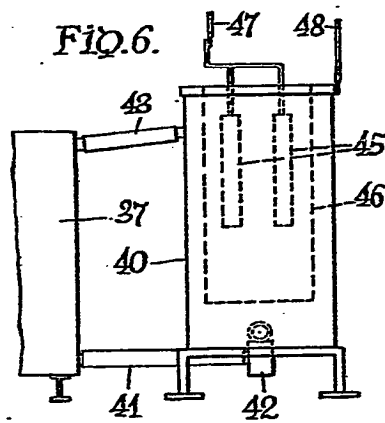
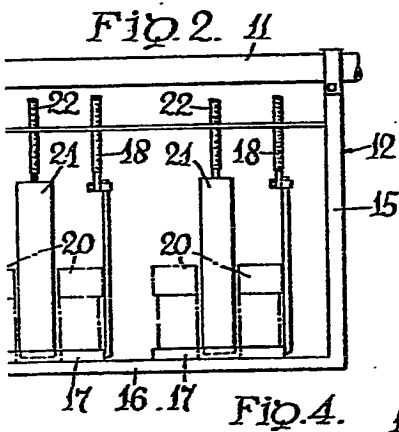


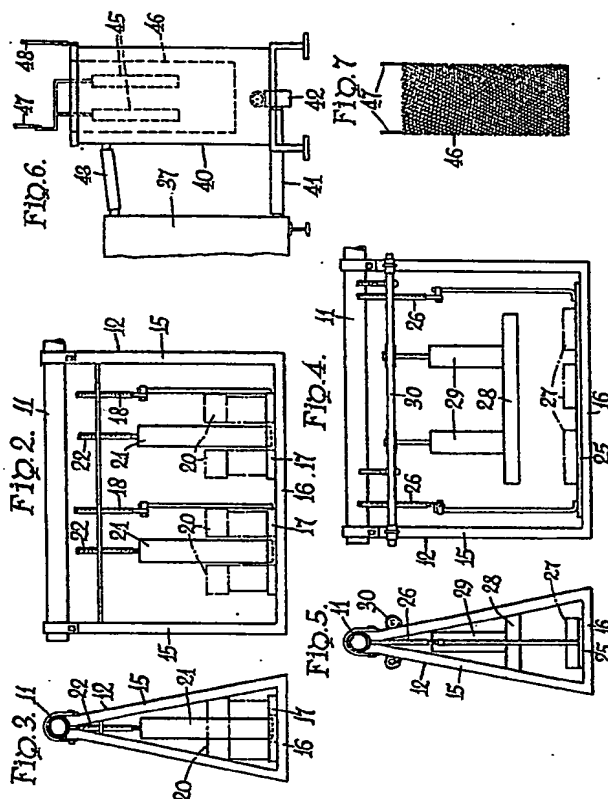
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